SpaceFibre Tutorial
International SpaceWire Conference 2018
Monday 14th May

SpaceFibre Tutorial

Immediately prior to the SpaceWire Conference in Long Beach, Los Angeles, Steve Parkes, who wrote the SpaceFibre standard with inputs from several spacecraft engineers, will deliver a detailed tutorial on SpaceFibre, explaining how the protocol operates and how it can be used to solve many communications problems on-board spacecraft. This tutorial is free for everyone registered for the SpaceWire conference.

Time: 14:00 to 18:00

Date: 14th May

Place: Westin Hotel, Long Beach, Los Angeles, California, USA

Programme:

1. Introduction to SpaceFibre: which outlines the primary applications, and gives a quick overview of how SpaceFibre works, and the protocol stack.

2. Physical Layer: which covers the physical media (electrical and fibre optic), and serialisation and de-serialisation.

3. Lane Layer: which looks at 8B/10B encoding/decoding, symbol and word synchronisation and lane initialisation.

4. Data Link Layer: which describes virtual channels quality of service, flow-control and fault detection, isolation and recovery.

5. Network Layer: which considers link interfaces, packets, routing switches and virtual networks and presents an example network architecture for an Earth Observation data-handling system.

6. Multi-Lane Layer: which describes Multi-Lane distribution and concentration, lane alignment, asymmetric operation, graceful degradation and hot redundancy.

7. Implementations: which concludes by looking as some implementations of SpaceFibre.

SpaceFibre

SpaceFibre is very high-speed data-link and network technology designed by the University of Dundee and STAR-Dundee to support high data-rate payloads, including synthetic aperture radar and hyper-spectral optical instruments. It provides robust, long distance communications for launcher applications and supports avionics applications with deterministic delivery constraints through the use of virtual channels. SpaceFibre enables a common on-board network to be used across many different mission applications resulting in cost reduction and design reusability. SpaceFibre is currently being designed into its first chips, boards, systems and missions.

SpaceFibre runs over both electrical and fibre-optic media and provides 3.125 Gbps data rate in current radiation tolerant FPGA technology. Higher data rates of 6.25 Gbps data rate per lane are possible with 65nm ASIC technology. SpaceFibre provides a quality of service mechanism which is able to support priority,

bandwidth reservation and scheduling. It incorporates fault detection, isolation and recovery (FDIR) capability in the interface hardware. SpaceFibre is designed to be implemented efficiently and has a much smaller footprint than other technologies such as Serial Rapid IO, taking 3-5% of a Microsemi radiation tolerant RTG4 FPGA, which allows plenty of room for the application specific logic.

Several SpaceFibre lanes can be operated in parallel (multi-laning) to give higher data rates or increased reliability. A multi-lane link can have any number of lanes from 1 to 16. Multi-lane operation provides hot redundancy and graceful degradation in the event of a lane failure, simplifying redundancy approaches and maintaining essential communication services over the remaining operational lanes. When a lane fault does occur, recovery is very fast, taking a few µs. SpaceFibre also supports asymmetric links where some of the lanes can be unidirectional. This is particularly useful for high data-rate instruments where data flow is mainly in one direction, and can save both power and mass.

SpaceFibre is backwards compatible with SpaceWire at the network level, using the same packet format, which allows simple interconnection of existing SpaceWire equipment to a SpaceFibre link or network.

SpaceFibre has a message broadcast capability, which carry eight bytes of user information, together with a broadcast type and channel identifier. This permits, for example, CCSDS unsegmented time information to be broadcast across the spacecraft in a single broadcast message, with low latency. Broadcast messages can be used for time distribution, synchronisation, event signalling, network control and error handling.

The ECSS-E-ST-50-11C SpaceFibre standard will be published in November 2018.